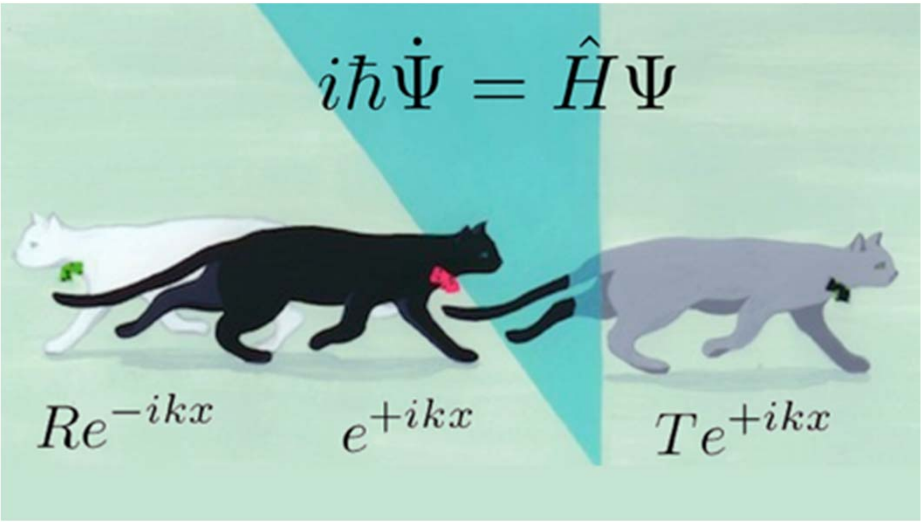
Exploring Quantum Physics

Coursera, Spring 2013 Instructors: Charles W. Clark and Victor Galitski

Using Feynman path integral

Part III: *Quantum corrections to diffusion* (continued)



Diffusion equation

- If many particles experience random walk, their (average) density satisfies the diffusion equation:

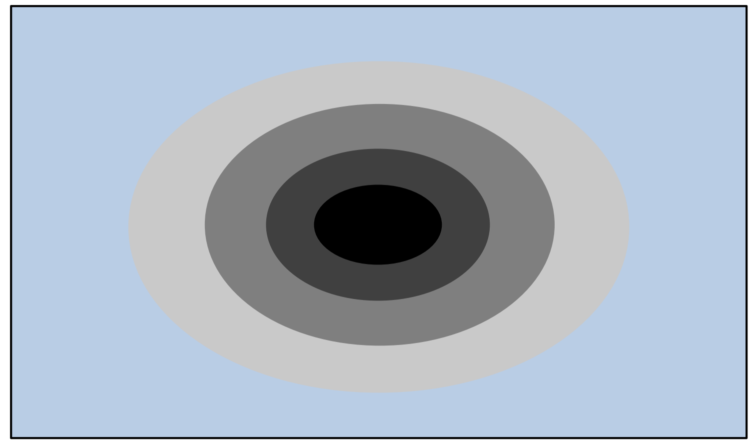
i

$D \to -\frac{\hbar^2}{2m}$

$$\underbrace{\frac{\partial \rho}{\partial t} = D\nabla^2 \rho}_{\rho(\vec{r},t)}$$

H

$$\underbrace{\rho(\vec{r}, t=0) = \delta(\vec{r})}$$



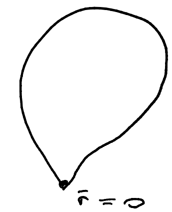
- Of particular interest is how the density spreads out from a point (e.g., from the origin)

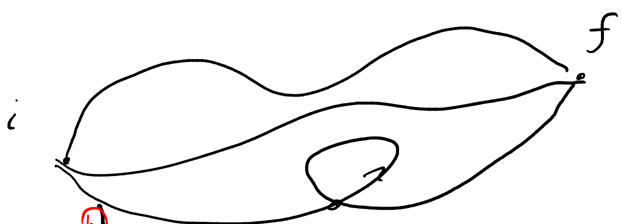
$$\underbrace{\rho(\vec{r},t) = \frac{1}{(2\pi D t)^{d/2}} \exp\left[-\frac{\vec{r}^2}{4Dt}\right]}$$

Probability of self-intersection

- Probability (density) to return to a close vicinity of the origin in a time t

$$\rho(\vec{r},t) = \frac{1}{(2\pi Dt)^{d/2}} \cancel{\exp\left[-\frac{\vec{r}^2}{4Dt}\right]} \xrightarrow{r \to 0} \boxed{\rho(\vec{0},t) = \frac{1}{(2\pi Dt)^{d/2}}}$$

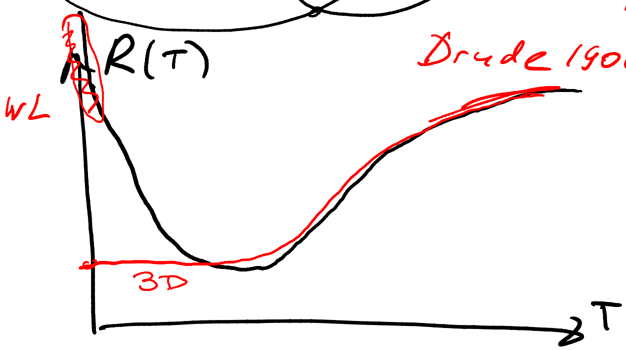




$$w^{quant}_{i\to f} = \sum_{l_1 \neq l_2}' 2\cos\left(\frac{p_F(L_1-L_2)}{\hbar}\right)$$

ΔL

$\cos 0 = 1$

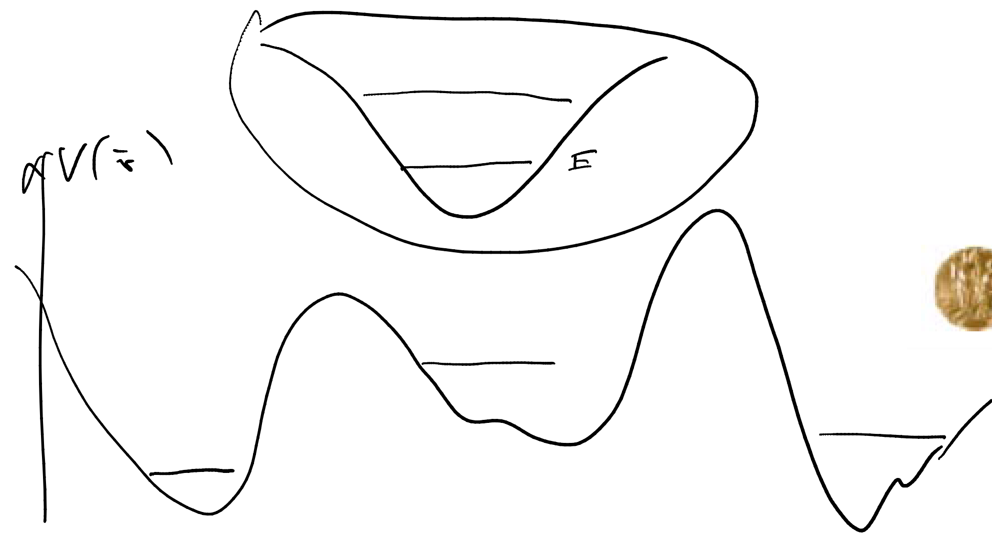


$$\boxed{P_{tot} = \begin{cases} \text{finite}, & d=3 \\ \infty, & d=1,2 \end{cases}}$$

Weak localization is a precursor to strong localization

Absence of Diffusion in Certain Random Lattices

P. W. Anderson
Bell Telephone Laboratories, Murray Hill, New Jersey
(Received October 10, 1957)



The Nobel Prize in Physics 1977
Philip W. Anderson, Sir Nevill F. Mott, John H. van Vleck

"for their fundamental theoretical investigations of the electronic structure of magnetic and disordered systems".